Q1.

A scientist found a polluted pond which had a new type of blue algae in the water.

The blue colour of the algae was caused by a mutation.

(a) What is a mutation?

_____

_____

(1)

The scientist measured the number of blue algal cells in a sample of the pond water.

The scientist used a special slide which has a counting grid.

This is the method used.

1. Dilute 2.5 cm^3 of pond water to a volume of 10 cm^3 with distilled water.
2. Place a drop of the diluted pond water on the special slide, as shown in **Figure 1**.
3. Place a thick coverslip over the diluted pond water to give a depth of 0.1 mm of pond water.
4. Use a microscope to count the number of algal cells in a 0.2 mm × 0.2 mm square on the counting grid.

Figure 1 shows a side view of the special slide.

Figure 1

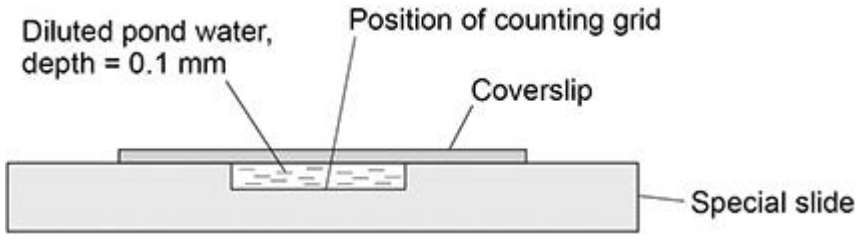
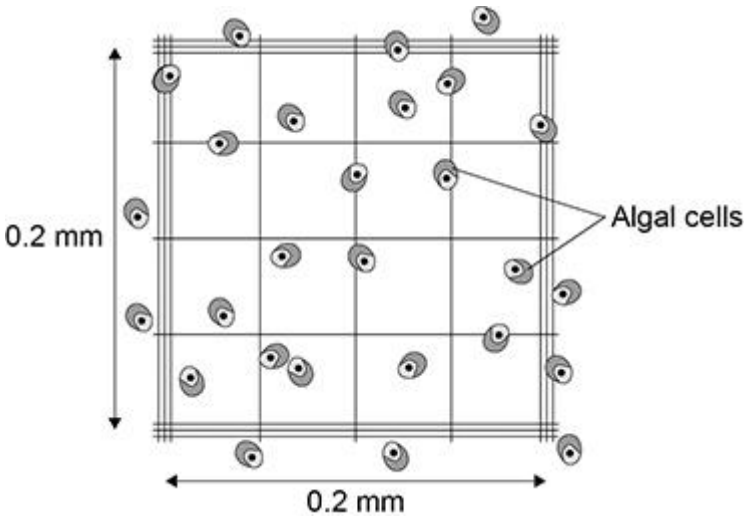


Figure 2 shows the view of the counting grid through a microscope.

Figure 2



(b) How many algal cells are in the 0.2 mm × 0.2 mm square in **Figure 2**?

Use the following procedure:

- Count all cells that are completely within the 0.2 mm × 0.2 mm square in the counting grid.
- Count cells that are touching the left side or the lower side of the square.
- Do **not** count cells that are touching the right side or the top side of the square.

Number of algal cells in the 0.2 mm × 0.2 mm square = _____

(1)

(c) One week later the scientist repeated the test and counted 14 cells on the 0.2 mm × 0.2 mm counting grid.

Calculate the number of algal cells in 1.0 mm^3 of **undiluted** pond water.

Use the scientist's second count of 14 cells.

Number of algal cells in 1.0 mm^3 of undiluted pond water = _____

(6)

(d) Suggest why the scientist diluted the pond water before placing it on the special slide.

(1)

(e) A student repeated the scientist's method.

The student used a thin coverslip over the diluted pond water instead of the thick coverslip.

The liquid pulled the thin coverslip downwards slightly.

Explain how the use of the thin coverslip would affect the results for the cell count.

_____

_____

_____

_____

(2)

(Total 11 marks)

Q1.

(a) any **one** from:

a change in
- DNA
- base code **or** nucleotide sequence
- a base (in DNA)
- a gene / allele
- part of a chromosome
- number of chromosomes
- genetic code / material

ignore genetic information

1

(b) 16 / sixteen

1

(c) *volume of sample in mm³*
0.004

1

number of cells in 1 mm³ ***diluted*** *pond water*
14 ÷ 0.004

allow 14 ÷ (0.2 × 0.2 × 0.1)
allow use of an incorrectly calculated volume of 0.04

1

3 500

allow ecf from answer to part (b) for number of algal cells

1

correct dilution factor

¼

allow dilution = ×4
or *4 times*

1

number of cells in 1 mm³ ***undiluted*** *pond water*
3 500 × 4

allow a calculation based on a dilution factor of 5

1

14 000 **or** 1.4×10^4

1

(d) to make it easier to count

ignore easier to see ***or*** *more spread out*
ignore quicker to count

1

(e) smaller volume

allow (some) liquid / cells would leak out (from under the

cover slip)

1

so fewer cells **or** lower cell count

*allow this mark **only** if there is an attempt at an explanation*

1

[11]

Q1.

This question was about the calculation of the population density of a microscopic unicellular alga and problems that might be encountered in the method of doing so.

(a) Since the unusual colour of the alga had been caused by a mutation, students had to define the term *mutation*. Just under two-thirds understood that a mutation was a change in the genetic material, such as DNA, a base, a gene or a chromosome.

(b) A description was given in the question of how a scientist set up a special slide with a counting grid in order to count the algal cells in a given volume of a suitably diluted sample of pond water. Section and plan diagrams of the special slide were given in **Figures 1** and **2**. Students then had to score the number of cells in a 0.2 mm × 0.2 mm square in **Figure 2**, observing the given rules for inclusion or exclusion of cells on the boundaries. Around three-quarters of students arrived at the correct answer of 16.

(c) This question was a 6-mark calculation to find the number of algal cells in 1 mm^3 of undiluted pond water from a count of 14 cells in the 0.2 mm × 0.2 mm square. Many students presented their working in a manner that was very difficult to follow, with a series of mathematical operations that were clearly not equalities yet that were all interconnected with 'equals' signs. A large proportion of students regarded the volume of the sample on the special slide as being equal to 0.2 × 0.2 = 0.04, forgetting to multiply by the depth of 0.1 mm to obtain an actual volume of 0.004 mm^3. Some misinterpreted the scientist's dilution factor: 2.5 cm^3 made up to 10 cm^3 is a 4-fold dilution, not 5-fold as many thought. Many did not consider the dilution and ended up with an answer of 3500 (or 350 with the incorrect volume) instead of the correct value of 14 000.

The correct calculation was simply:

$$\frac{14 \times 4}{0.004} = 14\,000$$

but only around 1 in 8 students arrived at this answer.

(d) To understand this question required thinking about the experimental situation and the results shown in **Figure 2**. If the pond water had not been diluted, there would have been 4 times the number of cells shown in **Figure 2** which would have made them impossible to count. Just over a quarter of students made any reference to the ease of counting. Some thought the algae would have been easier to see as the murky pond water had been diluted. Some answers were close – stating that dilution reduced the likelihood of cells overlapping – but did not then go on to state that they would thus be easier to count.

(e) The original information about the scientist's investigation included mention of a thick coverslip over the sample. In this question, information was given about a student trying to repeat the investigation but with a thin coverslip that was pulled downwards slightly, and asking for an explanation of what difference this would make to the cell count. Fewer than half scored any marks and only one in six scored both marks for stating that the volume would be reduced and the cell count therefore also reduced. There were various, highly inventive but incorrect, ideas such as a thinner cover slip allowing light to pass through more easily so more cells would be counted, or that the curved coverslip would somehow refract the light and alter the

count as a result. Many stated that the cell count would be ‘altered’ without being more specific about the direction of this alteration.